INVENTIONS & INNOVATION

Project Fact Sheet

Development of Phosphors for Use in High-Efficiency Lighting and Displays

Benefits

- Potential to double lighting efficiency compared to incandescent bulbs
- Less expensive and at least 20 percent more efficient than current high-efficiency fluorescent lamps
- Potential for high-impact payoff in residential, commercial, and industrial energy savings
- Promises positive economics of final products, leading to cost advantages, especially in large-scale production

Applications

The LED-excited phosphors are being developed to replace high-efficiency systems currently used in residential, commercial, and industrial lighting applications. In addition to lighting, however, a tri-chromatic system could also provide a full-color gamut for application in flat panel television and computer displays. This use cannot currently be achieved with the existing di-chromatic technology.

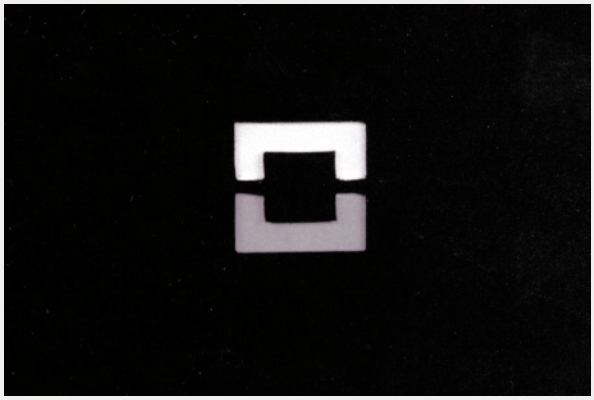
New phosphors lead to improved color rendering and significant energy savings in high-efficiency, LED-activated lamps and displays

The development and use of efficient fluorescent lamps over the past few decades has been a major factor in controlling electricity consumption in the United States. Presently, two different kinds of fluorescent lamps are used: one is based on a two-color (di-chromatic) system, while the other is based on a three-color (tri-chromatic) system. In both cases, the phosphors are excited primarily by the short wavelength (254 nanometer) light produced through mercury discharge in the lamp.

While these systems are effective, the future of high-efficiency lighting rests in the use of light-emitting diodes (LEDs). Because LEDs provide a more efficient excitation source than mercury discharge, they can operate at least 20 percent more efficiently than the highest-efficiency fluorescent lamps.

A new technology devised by Brilliant Technologies, phosphors for use in high-efficiency lighting and displays, may achieve these higher efficiencies. This new technology will use two phosphors, each emitting in different colors, to produce a true, tri-chromatic color set at 450 nanometers (nm). To date, no suitable phosphors have been developed that efficiently absorb light in the 420-470 nm range and emit in the necessary portions of the color spectrum. Once developed, however, their potential in the marketplace as an inexpensive and superior replacement for existing incandescent and fluorescent bulbs is promising.

Red and Green Emitting Phosphors



Brilliant Technologies is developing red and green emitting phosphors that produce a true, tri-chromatic color set. This development could eventually provide twice the lighting efficiency of incandescent light bulbs.

Project Description

Goal: Identify key materials and process parameters for maximizing system brightness and energy efficiency while minimizing cost.

Lamps operating on a di-chromatic system (two phosphors independently emitting blue and yellow light) produce 75-80 lumens per watt (W) of a white-appearing light. These lamps have many applications, especially in industry. Higher-efficiency, but less-widely used lamps employ a tri-chromatic system (three phosphors independently emitting red, green, and blue) to produce white light. These lamps output approximately 100 lumens per watt.

However, even higher efficiencies are possible through the use of light emitting diodes. Because white light cannot be produced directly from LEDs, an indirect approach is required. For this process, part of the light from a blue-emitting LED is directed onto a yellow-emitting phosphor. The result is a white-appearing light that is produced at least 20 percent more efficiently than the highest-efficiency fluorescent lamps.

This level of efficiency can be improved even further by using two phosphors, one emitting in the green portion of the spectrum and the other in the red portion, to produce a true, tri-chromatic color set with blue LED activation. This type of system does not yet exist because the appropriate phosphors have not been developed. These phosphors are the target of the research, however, and recent work by Brilliant Technologies has yielded significant evidence indicating that the phosphors can be developed.

Brilliant Technologies, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- The developer has recently discovered and patented two new sets of phosphors that show promise for application in white, tri-chromatic LED sources.
- Results from continued work reflect a high probability of success in achieving the project goal.
- Brilliant Technologies has attracted additional support through a commercialization partnering agreement with Oregon State University.

Economics and Commercial Potential

The U.S. Energy Information Administration (EIA) reports that residential lighting accounts for approximately 100 billion kWh of energy consumption annually. An estimated 98 percent of homes still use incandescent bulbs for lighting, while 42 percent have turned at least in part to fluorescent tube-style lamps. Only about 10 percent of residences use compact fluorescents.

Lighting in the commercial sector, an estimated 400 billion kWh annually, consumes four times as much energy as the residential sector. The majority of commercial buildings already operate with fluorescent lighting, but there is still ample opportunity for energy savings in lighting. Replacing old-style ballasts with new, electronic ballasts would save an estimated 25 percent. In addition, the replacement of all bi-color, 80 lumens per watt lamps with tri-color, 100 lumens per watt systems would increase efficiency another 25 percent.

The proposed LED-excited phosphors are superior to existing lighting systems and promise to be approximately 20 percent more efficient than even the highest-efficiency fluorescent lamps currently available. Moreover, it is expected that these new phosphors may be produced under the $1,000/kg price typically targeted on other phosphors used for lighting. If the developer can successfully meet the project goal, this new technology should benefit substantially from both its broad application in the marketplace and its strong cost competitiveness.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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